Questions on microwave electronics

Environment, Electricity



MICROWAVE ELECTRONICS

Duration: 2 hours 30 minutes

YOU ARE NOT PERMITTED TO READ THE CONTENTS OF THIS QUESTION PAPER UNTIL INSTRUCTED TO DO SO BY AN INVIGILATOR.

Answer FOUR

Questions. The Smith Chart is Attached. calculators arE permitted in this examination. Please state on your answer book the name and type of machine used. Complete all rough workings in the answer book and cross through any work which is not to be assessed important.

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Answer the following questions on the Smith Chart and its applications.

(a) Starting from the definition of Reflection Coefficient, explain the construction of the Smith Chart. It is NOT necessary to derive the equations for the constant impedance and constant reactance circles.
[8 marks] It is a polar plot of the complex reflection coefficient. It is also known as the 1-port scattering parameter s or s11, for reflections

from a normalized complex load impedance z = r + dx; [4 marks] [2marks] [2marks].

(b) Consider the transmission line circuit below (Figure 1). Use the Smith Chart to find SWR on the line, the return loss, the reflection coefficient at the load, the load admittance, the input impedance to the line, the distance to the first voltage minimum, the distance from the load to the first voltage maximum. [9 marks] 0. 8 Wavelength Z0 = 50 ? ZL = 70+j40 ? Zin Figure 1 1mark for each answer except for the last two (2 marks) (c)A load impedance of ZL = 100-j150 ? is to be matched to a 50? line using a single shunt-stub tuner. Find two solutions using short-circuited stubs. [8 marks] 2 marks each for the following four answers [pic]

Question 2

- (a) Consider an arbitrary microwave transistor with scattering matrix
 [S], connected to source and load impedances as shown in Figure 2. Derive the following equations concerning (in and (out. [7 Marks] with reference to figure 1, the reflection coefficient is seen looking forward the load is while the reflection coefficient seen looking toward the source is [1 Marks] in general, the input impedance of the terminated two-port network will be mismatched with a reflection coefficient given by (in, which can be defined by the following analysis. From S parameters definition, Eliminating V2-, and solving for [4 Marks] Similarly, (out can be obtained. [2 Marks]
- (b) In a transistor oscillator, a one-port negative-resistance is effectively created by terminating a potentially unstable transistor with

an impedance designed to drive the device in an unstable region as shown in Figure 2. [pic] Figure 2 Assuming that S parameters of the transistor in a common-gate configuration are S11=(2. 18, -35(),S12=(2. 75, 96(), S21=(1. 26, 18(), S22=(0. 52, 155()). Design load and terminating networks using a combination of one-eighth and a quarter wavelength impedance transformers for a microwave oscillator. Please note that the stability circle can be calculated using the following equations [18 Marks].

- S11 is quite big, which means that the common gate transistor configuration is unstable
- The center and radius of the output stability circle in the (T plane are CT=(1. 08, 33(), RT= 0. 665 [4 Marks]
- Since | S11|= 2. 18> 1, then the stable region is inside the stability circle, this gives a large amount of freedom to choose (T plane.
- T is selected as (0. 59, -104). Then an impedance matching network is used to convert ZT into 500hm match load
- From (T, (in=(3. 96, -2. 4(). It is obtained from [pic] Zin can be found to be (-84-j1. 9)Ohm, and then ZL(()= -Rin(()-jXin(() A matching network is chosen to match ZL with 50Ohm load [10 Marks] Based on the following equations, an impedance matching network can be designed (T is selected as (0. 59, -104(), ? T can be found as Zin can be found to be (-84-j1. 9)Ohm, and then ZL(()= -Rin(()-jXin(()= 84+j1. 9)

Question 3 Answer the following questions about microwave amplifiers:

- a)Show that for a unilateral device, where S12= 0, the (-parameter test implies that | S11 | < 1 and | S22 | < 1 for unconditional stability.
 Where the (-parameter test is formulated as [8 marks].
- b) Use the (-parameter test to determine which of the following devices are unconditionally stable, and of those, which has the greatest stability. [6 Marks].